PLEASE QUOTE
FILE 21044

GOVERNMENT OF THE NORTHWEST TERRITORIES
CANADA

Glen Kirby
re Green Houses

Frobisher Bay, N. W. T.
8th December 1972

Director
Department of Industry & Development
YELLOWKNIFE
North West Territories

RECEIVED
OFFICE OF THE DIRECTOR
DEC 21 1972
INDUSTRY & DEVELOPMENT

Re: Greenhouses in the Arctic

I refer to our discussion of greenhouses and to your request that I forward to your office an outline of the proposal of using surplus heat from power plants to heat a greenhouse capable of supplying a basic line of fresh vegetables for small isolated northern communities.

The proposal is based on the following criteria; Settlements with no airstrip or regularly scheduled flights; Settlements where cost of air freight is higher than normal even if hauled by charter flight; Settlements with a total population not exceeding two hundred people. (The last can be considered as an arbitrary figure).

In the Baffin Region we have two communities that meet all of the above criteria, these are Grise Fiord and Port Burwell. One other community, Lake Harbour fails in one aspect, the population is slightly higher than 200. As Grise Fiord is our most northerly point and Port Burwell our most southerly point; we have a good argument in favour of establishment of two greenhouses in this Region.

The following data has been gathered by our staff at Regional Headquarters and can be considered as basic groundwork. Success of a

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project of this nature is dependent on research at the field and at higher levels. In this instance we see the possible involvement of the National Research Council and the Sylvania Corporation.

Requirements:

1. Suitable building - 30 feet by 48 feet.
2. Suitable Soil - Local or imported - sterilized and fertilized.
3. Water Supply - Storage Tank or other.
4. Light - Natural sun and artificial.
5. Heat - Waste heat from power plants.
6. Planters - Wooden or galvanized half culvert.

(1). <u>Building</u>:

The building should be of strong construction, requiring only sidewall, endwall and rafters. The floor should be gravel as this will help to keep the humidity at the required level.

The side and endwalls can be of plywood sheathing or metal, plywood may prove to be most suitable as the metal siding is a greater conductor of cold and can also be considered as a reflector of heat. It is assumed that whether plywood or metal siding is used that the side and end walls will be insulated.

The roof of the greenhouse can be of, (a) ordinary glass, (b) plexiglass (c) fibreglass, or (d) plastic film. Probably the most suitable would be fibreglass panels but these are expensive and related labour costs for installation would be high, due mainly to the required precision spacing of the supporting roof members.

Second preferance would be plastic film as this material is relatively inexpensive and simple to install. Double thickness (two) layers may be necessary in areas of strong winds. This material should be installed during a calm period and never when the

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wind speed is in excess of five miles per hour.

A storm porch should be part of the greenhouse although this is not shown on the attached diagrams.

(2.) Soil:

Suitable soil for a project of this type is not always available locally. Where a local supply of soil is available, samples should be taken and sent to a laboratory for analysis and testing for fertilizer requirements.

As the production rate in a greenhouse is dependent on the quality of the growing medium(soil), care should be taken in the initial stages to ensure that proper soil is obtained. Soil especially if imported should be sterilized to eliminate weeds and insects.

(3.) Water:

Water, heated by the power units would be the preferred method of heating the greenhouse. Therefore, an adequate storage tank would be required as an integral part of the system within the power house, see attached diagram - No. 1. Capacity of this particular tank can easily be established by the engineers responsible for the power system.

In addition a tank of not less than 250 gallons in capacity should be installed in the greenhouse to provide water for the plants through a water distribution system as shown in the attached floor plan layout (Diagram No. 2). This tank should be of the open top variety to assist in maintaining the required level of humidity. Provision should be made for a heating system that will maintain this water supply for the plants at a temperature of 65-70° degrees fahrenheit (room temperature).

(4.) Light:

Natural light will be the main source being diffused by the (if

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approved) plastic film. Supplementary artificial light will also be required and the following, based on a requirement of twelve hours minimum for average growth rate should be considered.

The effect of light, whether natural or artificial on plant growth must be recognized. In support of this statement I would refer you to the publication "Scientific American" issue on "Light", dated September, 1968. A brief extract showing the effect of light on plant growth is attached, (attachment No. 3). I would ask that you particularly note the caption on the attached photo copy that reads, ..."Long Light Periods markedly influence the growth of Douglas fir. When exposed to short days, or days and nights of equal length, the tree will remain dormant (left). Excitation by additional light produces continuous growth. One tree (centre) received an hour of dim illumination during its twelve hour night; the other (right) had its twelve hour day extended by eight hours of dim light..."

The example of the effect of light on the growth of the Douglas fir is probably an extreme example. However, similar effect will be seen on all plant growth but will probably not show so marked a difference as in the case of the Douglas fir.

As a supplementary artificial light source consideration should be given to the use of Sylvania Wide Spectrum Gro Lux flourescent lamps. These lamps have proven successful in an experimental sunless greenhouse operated as part of the Sylvania Corporation's research program, see attached advertisement (attachment No. 4)

Another artificial light source that may be used would be Mercury Vapour Lamps. These lamps must be used in conjunction with ordinary incandescent lamps in order to give the necessary mix of red and blue light. This system is probably less efficient and certainly more expensive than the Wide Spectrum Gro Lux Lamps mentioned earlier.

(5.) <u>Planters</u>:

There are a number of ways in which Planters may be constructed

for this exercise we will consider only two; the wooden trough type and the half round galvanized culvert.

(a) The wooden planter with hardware cloth and wooden slat bottom is useful in that it provides good drainage in the event of over watering and retained moisture in the wood helps to maintain the required level of humidity inside the greenhouse.

(b) Galvanized half culvert, should be a minimum of three feet in diameter, the horizontal half sections should be of the "bolt together" type. Use of culvert material can give added strength to the structure and installation labour costs would be less than for the wooden trough installation.

Use of the galvanized culvert calls for a bed of sand and gravel to a depth of six inches and a row of evenly spaced holes along the bottom of the trough to facilitate drainage.

Care in watering is necessary with this type of planter to avoid over saturation of the growing medium.

(6.) Heat:

The use of waste heat from the power units, efficiently transferred to the greenhouse would be the controlling factor determining the viability or non-viability of a project of this nature.

There is at present the technology and equipment available to recover the waste heat from the power units in the settlements to efficiently heat the proposed greenhouses. It is estimated that a 60 KW unit would easily provide enough heat for a greenhouse measuring 30 feet by 48 feet or approximately 15,000 cubic feet.

Waste heat from the power units is presently being vented off into the atmosphere, (1) through the exhaust system and (2) through the radiator and building vent system. (see diagrams No.'s 1 & 5 which are attached)

In discussion with personnel from Northern Canada Power Commission it was decided that recovery of heat from the exhaust system would be; greatest quantity; most efficient; most practical and, most expensive.

Recovery of waste heat from the exhaust systems is not a new idea, this principle has been used in a trouble free manner on all Dewline

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There is at present the technology and equipment available to recover the waste heat from the power units in the environments to efficiently heat the proposed greenhouse. It is estimated that a 60 KW unit would easily provide enough heat for a greenhouse measuring 38 feet by 48 feet or approximately 15,000 cubic feet.

Waste heat from the power units is presently being wasted off into the atmosphere, (i) through the exhaust system and (ii) through the radiator and building vent system. (see diagrams no.'s 3 & 5 which are attached)

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Recovery of waste heat from the exhaust systems is not a new idea, this principle has been used in a trouble free manner on all Foellen

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sites since the days of their construction. We propose to use this established method which requires a dual exhaust system fitted on one side with a "Wet Silencer" and heat flow controlled by water temperature through a butterfly valve system. See attached diagram, not drawn to scale, for details.

It is in your interest to know that on all Dewline sites now owned by the N.W.T. Government that these dual exhaust systems complete with "Wet Silencers", are still on site in their original installations. It may be possible to recover two of these units from the site at Rowley Island for use in this proposed project.

(7.) Production:

The estimated production capability from a greenhouse such as this project calls for, (see scale drawn floor plan, attached) should approach the level of requirement for a settlement of up to 200 in population. The following estimated production figures from one crop per year are based on average production from good quality plants that are well fertilized, watered correctly, and generally well looked after.

[illegible] 1000 lb	Potatoes	1,500 lb.	[illegible]	Keys 4 mo
3000 lb	Tomatoes	1,300 lb.		2 wk
2500 lb	Onions	350 lb.		3 mo
2500 lb	Carrots	200 lb.		6 mo

The above plus a fair supply of radishes, lettuce and cucumbers can well be produced. From the evidence we have on hand two crops per year could well be produced. Surveys of the local grocery stores indicate that potatoes, tomatoes, onions and carrots are the vegetables most preferred by the Inuit.

Although the main purpose of this proposal is to provide isolated communities with a supply of fresh vegetables at a reasonable cost, the potential for research must not be ignored. To this end, I would suggest that contact be made with the National

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Research Council of Canada, and the Sylvania Corporation Research Facility in the U. S. A. to obtain any available data that they may have and which may prove valuable to a project of this nature. It may also be possible to interest both of these institutions to participate in this proposed experimental project. With further research I am sure that other benefits can accrue from the use of waste heat from the many power units in the N.W.T.

General:

A problem that may be encountered would be that of proper management of the production facility. A person qualified in this field who has the capability to act as a project manager and at the same time train a local person to take over the project after two crops have been grown and harvested will be required.

Distribution of products can be handled by the project manager who could sell to individuals or utilize existing retail facilities.

This proposal if accepted and implemented, could be a source of information to communities wishing to establish their own greenhouse facilities and also, could well be implemented on a much greater scale if included in the planning as part of the basic facilities in any new mining operations such as Strathcona Sound and Mary River.

Today, with all emphasis being placed on pollution control, it would be pleasant indeed, if this utilitarian project could fill the dual role of benefit to a community and at the same time contribute to the reduction of pollution in a given area.

If this project, after further research is implemented, and the chosen location is Grise Fiord, I am sure that publicity for such an operation North of the 76th parallel would be tremendous. (Fresh vegetables and pollution control all in one small package).

In closing I would like to extend my thanks to the following contributors for their patience, support and assistance in putting this proposal on paper: Mr. S. Sime and Mr. W. Patterson of Northern Canada Power Commission; Mr. D. Patterson, Regional Tourism Officer, and Mr. E. Martin, Area Game Officer for Broughton Island.

Please consider this proposal as a combined operation from Industry and Development and Northern Canada Power Commission. Your comments would be appreciated.

J. B. Haining
Regional Superintendent
Industry & Development,
for Regional Director

Att.

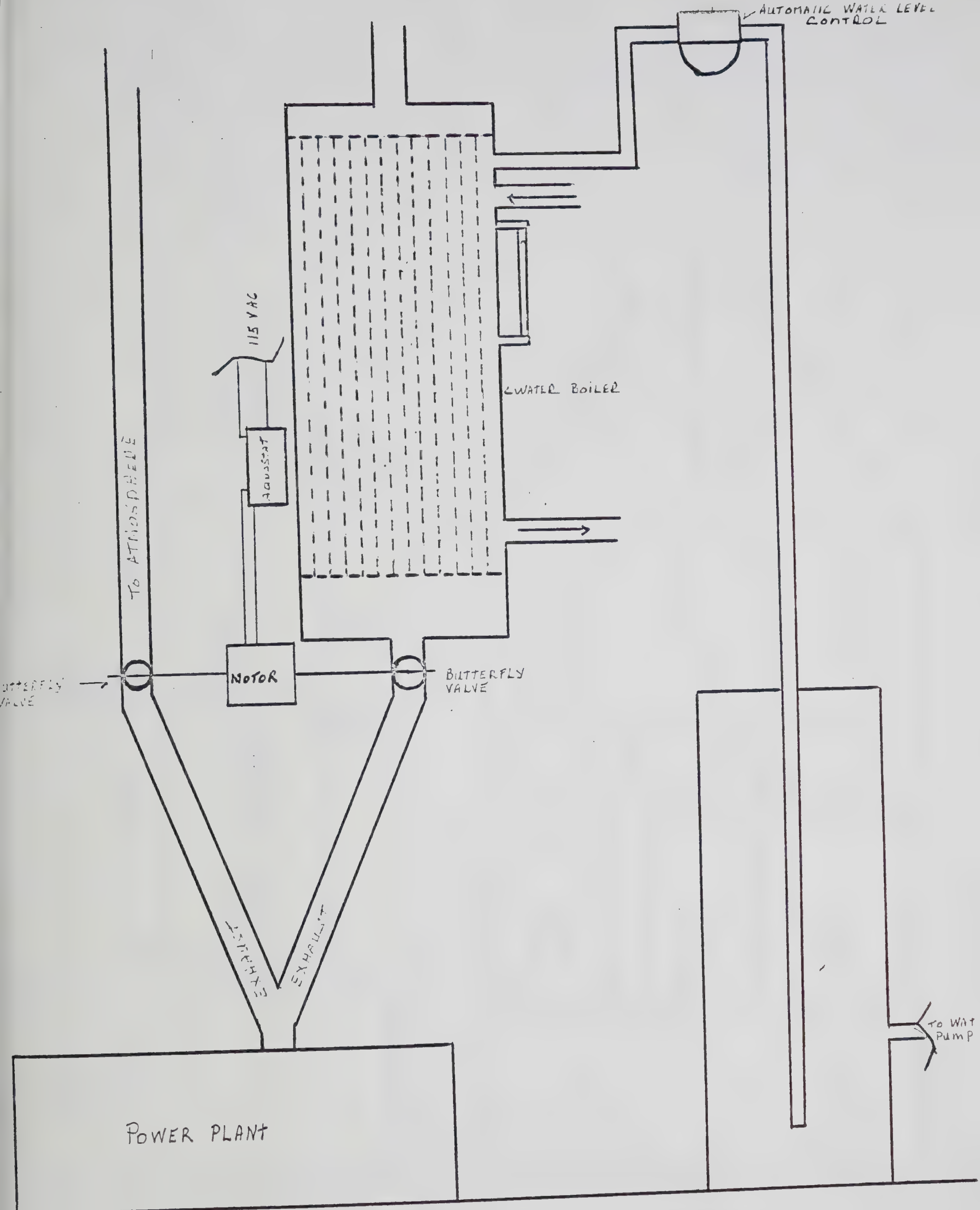

AUTOMATIC WATER LEVEL CONTROL
115 VAC
AQUASTAT
WATER BOILER
TO ATMOSPHERE
BUTTERFLY VALVE
MOTOR
BUTTERFLY VALVE
EXHAUST
EXHAUST
POWER PLANT
TO WAT PUMP

DIAGRAM NO. 1

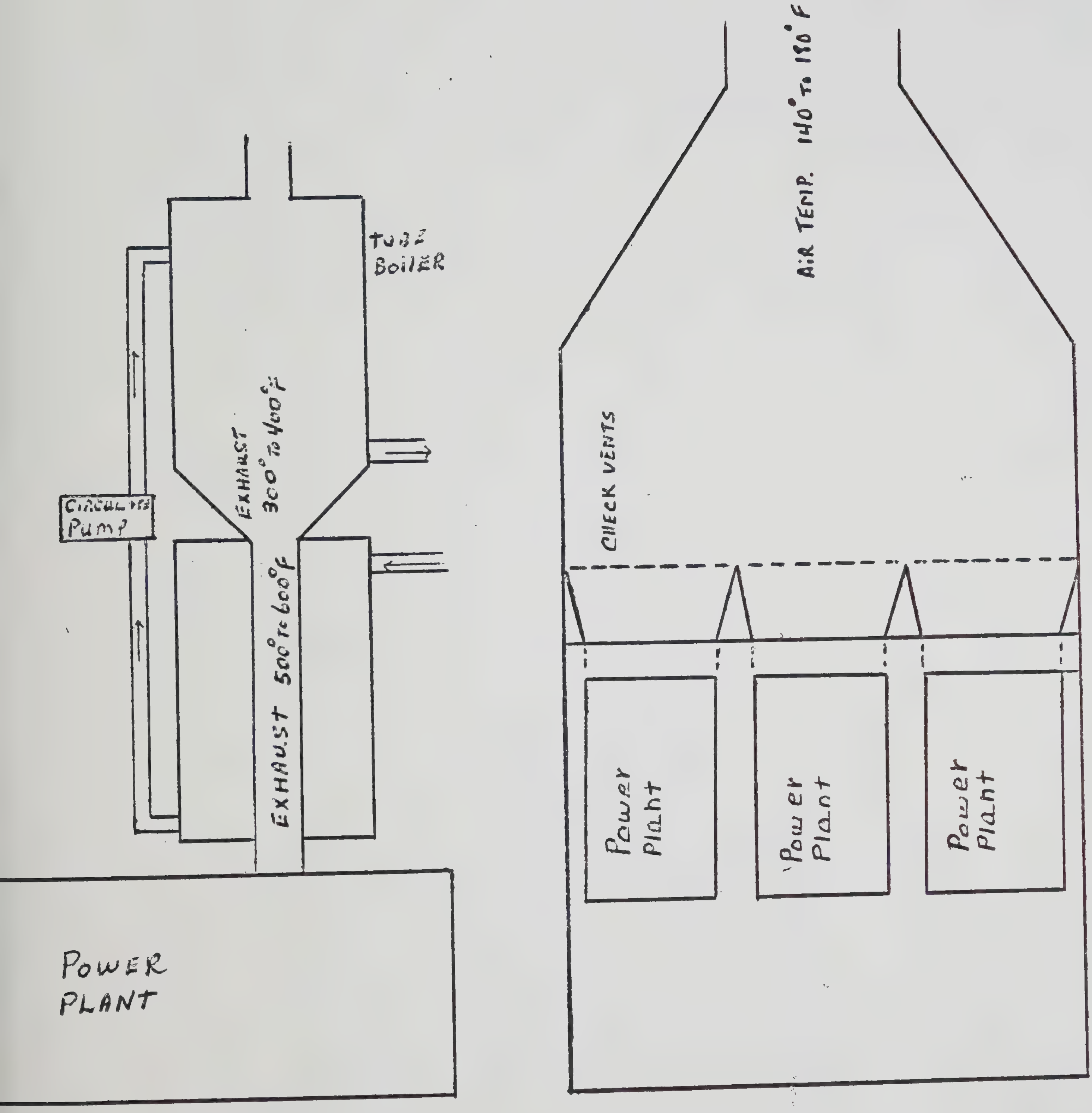
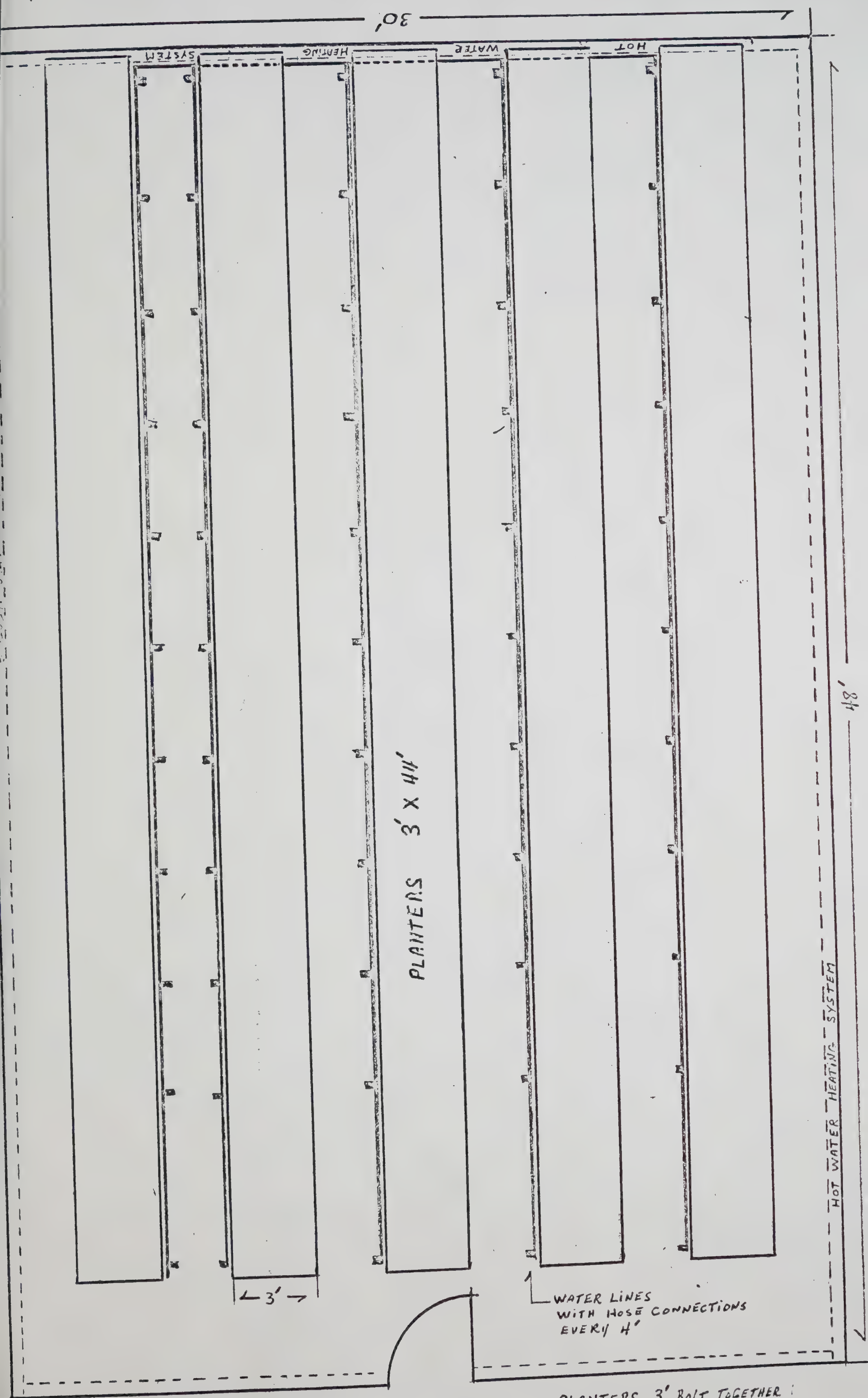

TUBE BOILER
Pump
EXHAUST 300° TO 400°F
EXHAUST 500° TO 600°F
POWER PLANT
CHECK VENTS
AIR TEMP. 140° TO 150°F
Power Plant
Power Plant
Power Plant

DIAGRAM NO. 5



PLANTERS 3' BOLT TOGETHER :
CORRIGATED DRAIN PIPE

SCALE 1/4" = 1 FOOT
GREENHOUSE FLOOR PLAN

DIAGRAM NO. 2

[illegible]

of plant depends on the presence of the final, far-red-absorbing form of phytochrome. Little is known about how the far-red-absorbing molecule does its work. One view is that it regulates enzyme production by controlling the genetic material in cell nuclei. Another view is that the molecule's lipid solubility results in its being attached to membranes in the cell, such as the cell wall and the membrane of the nucleus. Changes in the form of the phytochrome [illegible]

[illegible] ability of the membranes and therefore the functioning of the cell.

The continuous exposure of plants to blue and far-red wavelengths in the visible spectrum opposes the action of the far-red-absorbing form of the phytochrome molecule. It may be that excitation by far-red light causes a continuous displacement of the far-red-absorbing molecules from cell membranes. Continuous excitation of this kind is what happens, for example, during the long [illegible]

the growth of Douglas firs. If the trees are exposed to 12-hour days and 12-hour nights, they remain dormant. If the length of the day increases, however, they grow continuously.

Photoperiodism is not confined to the plant kingdom: animals also respond to changes in the length of the day. The migration and reproduction of many birds, the activity cycles of numerous mammals and the diapause (suspended animation) of insects are controlled in

LONG NIGHT PERIODS markedly influence the growth of Douglas fir. When exposed to short days, or days and nights of equal length, the tree will remain dormant (*left*). Excitation by additional light produces continuous growth. One tree (*center*) received an hour of dim illumination during its 12-hour night: the other (*right*) had its 12-hour day extended by eight hours of dim light.

ATTACHMENT NO. 3

Doctors search for the answer to everlasting life. Scientists search for the answer to how life began. Man's basic instinct is to strive for perfection.

At Sylvania it's no different. Our search is for a perfect light. A light that will last forever and give off the exact natural light of the sun. Sounds like an impossible task? Well, to tell you the truth, it is.

To begin with, man can't reproduce the exact conditions of the sun. And even if he could, the intensity of heat which such a light would give off, would be 6,000 degrees centigrade.

Knowing this, we could be satisfied with what we have, and not go any further. But we aren't. The basic instincts of our engineers drive them on a never-ending search for perfection. As a result, here are some of the products we've developed in trying to emulate that giant white fireball in the sky.

We have an experimental sunless greenhouse at the Sylvania Lighting Center in Danvers, Mass., where we've actually grown tomatoes, potatoes, and exotic flowers without the light of the sun. Their only source of light has been from our Wide Spectrum Gro-Lux® fluorescent lamps.

Gro-Lux lamps are made with a special combination of rare earth phosphors, and give plants all the light they need to grow on: two different wave length bands of energy in the red and blue regions. This allows them to go through the action spectrum of chlorophyll synthesis and photosynthesis. With Gro-Lux lamps it's easy to grow seasonal foods like tomatoes and pineapples out of season in a simple basement set-up.

Our experiments have worked out so well that Gro-Lux lamps are being used in cabins of simulated spacecraft to grow vegetables for astronauts. And at a later time there will be plans to use Gro-Lux lamps on actual long-distance manned spacecraft. Up in the sky or down on earth, there's no limit to the help Gro-Lux lamps will be in the future. Especially when we're faced with feeding the exploding population.

In searching for the unattainable in our electroluminescence lab, we found another new method of generating light. Panelescent® lamps. There's no gas, no glass, no bulbs, no tubes. Panelescent lamps are two dimensional lamps that work similarly to the luminescence we see in fluorescent lamps: the light is produced by exciting a phosphor.

Panelescent lamps can be made into practically any shape from a tiny curlycue to a monolithic structure. They can take any size from 1/16″ to 2 ft. x 8 ft. This provides an endless list of possibilities. Ceilings can be

ATTACHMENT No 4